PHASE I - INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

COLSTRIP EVAPORATION POND DAM

ROSEBUD COUNTY, MONTANA

MT - 3211

PREPARED FOR:

HONORABLE TED SCHWINDEN
GOVERNOR, STATE OF MONTANA

AND

MONTANA POWER COMPANY
OWNER / OPERATOR

PREPARED BY:

Christian, Spring, Sielbach & Associates
Bozeman, Montana

Assisted BY:

Northern Testing Labs, Inc.
Great Falls, Montana

JUNE 1981

Seattle District
United States
Army Corps of Engineers


DIVERSION DAM
WEST DRAIN
TO FORSYTH
EAST DRAIN
COAL MINE
CASTLE ROCK RESERVOIR
OUTLET WORKS
EMERGENCY SPILLWAY
MOBILE HOME PARK
LIGHT INDUSTRY
DAM
FUTURE TOWNSITE EXPANSION
SADDLE DAM
WATER TREATMENT PLANT
TOWNSITE EXPANSION
SCHOOL
MT. HWY. 39
COAL STRIP
B. N. RAILROAD SPUR
COAL FIRED POWER PLANTS
UNDER CONST.

TABLE OF CONTENTS

EVAPORATION POND PHOTOS

Photo 1. Upstream Slope

Photo 2. Runoff Erosion on Upstream Slope

Photo 3. Wave Erosion

Photo 4. Erosion Caused By Pipe Discharge

Photo 5. Downstream Slope and Right Abutment

Photo 6. Emergency Spillway Entrance

EVAPORATION POND PLATES

1. Location Map
2. Drainage Map
3. Townsite Expansion
4. Dam Plan
5. Dam Sections
6. Dam Profile
7. Emergency Spillway Plan and Profile
8. Emergency Spillway Rating Curve

EXECUTIVE SUMMARY

Personnel of Christian, Spring, Sielbach & Associates, principal contractor, and Northern Testing Laboratories, Inc., subcontractors, under a contract with the Montana Department of Natural Resources and Conservation (MDNRC) and with representation from the Montana Power Company and the MDNRC, inspected the Evaporation Pond Dam on September 4, 1980, under the authority of Public Law 92-367. The project is located principally in Section 29, Township 2 North, Range 41 East, MPM, offstream of Armell's Creek in Rosebud County, Montana, less than 2 miles NW of the town of Colstrip, Montana.

This report was compiled from information obtained during the onsite inspection, review of Bechtel Corporation design reports, construction plans, and analysis of available hydrologic information. Findings were compared with engineering criteria that are currently accepted by most private and public agencies engaged in dam design, construction and operation. The overall project is composed of the Evaporation Pond Dam, which is the subject of this report, and the Diversion Dam which intercepts natural flows before they reach the Evaporation Pond. The Diversion Dam inspection is contained in a separate report.

FINDINGS AND EVALUATIONS

The Evaporation Pond Dam and appurtenances were constructed in 1976 by the Montana Power Company with engineering design and construction management services provided by the Bechtel Power Corporation. The project is owned and operated by the Montana Power Company. The reservoir provides storage for flyash from a coal-fired generating complex at Colstrip.

The 70-foot-high Evaporation Pond Dam impounds approximately 3834 acre-feet of water at dam crest elevation 3308.0 feet National Geodetic Vertical Datum (NGVD). Flyash storage will eventually consume 2360 acre-feet. Elevations are based on levels taken during the inspection and using elevation 3308.9 at the southwest corner of the pump station slab as a temporary benchmark. On the basis of criteria in the U.S. Army Corps of Engineers Recommended Guidelines for Safety Inspection of Dams (Ref. 1), the project is intermediate in size.

The sudden failure of the dam impounding the Evaporation Pond would cause flooding in a development just north of the town of Colstrip and result in extensive property damage and endangering many lives. However, no dam breach analysis or routing of a dam breach flood was made for the project. The conclusions on probable damage are based on a brief field visit and engineering judgment. The project is classified as having a high (Category 1) downstream hazard potential.

Inspection criteria (Ref. 1) recommend that an intermediate size project with a high downstream hazard potential be capable of safely handling the probable maximum flood (PMF). The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region. The estimated PMF for the 0.54 square mile drainage basin resulted from a 72-hour general storm

probable maximum precipitation (PMP) developed for this dam safety study. The resultant PMF has an estimated volume of 767 acre-feet. The maximum discharge capacity of the emergency spillway with the reservoir at dam crest elevation 3308.0 feet NGVD is 625 cfs. For routing studies of the PMF the initial reservoir elevation was assumed to be at the spillway crest elevation 3304.0 feet NGVD. The studies show the Evaporation Pond project successfully passes the PMF without overtopping. The maximum water surface elevation during the PMF routing was found to be 3306.7 feet NGVD; more than 1.3 feet below the dam crest. Maximum spillway outflow was found to be 294 cfs.

The visual inspection of the dam embankment found no evidence of settlement, cracking, or misalignment. The upstream slope which has a layer of soil-cement on the slope face, shows evidence of wave and surface runoff erosion. Discharge from a pump station on the dam crest has eroded an isolated area on the lower portion of the slope. The down stream slope is generally well covered with grass. Some surficial sloughing of topsoil and minor runoff erosion rills were observed. No seepage was seen on the slope or in the abutment contact areas. The reservoir level at the time of inspection was at elevation 3262.3 feet NGVD, 46 feet below the dam crest, therefore seepage heads have been minor in relation to potential. No embankment performance monitoring devices or other instrumentation have been installed.

The design analysis procedure and criteria for stability of the Dam embankment and foundation are in accordance with Recommended Guidelines for Safety Inspection of Dams (Ref. 1). Factors of safety obtained meet or exceed the criteria. Based on our review of available information and the visual inspection it is our judgment that dam embankment stability of the Evaporation Pond Dam conforms with the recommended guidelines. Reservoir storage and spillway capacity is adequate to handle the recommended spillway design flood.

The earth emergency spillway excavated in the left abutment is devoid of vegetation on cut slopes. A service road is located adjacent to the spillway approach channel.

RECOMMENDATIONS

Implement and periodically test a warning plan to warn downstream residents in the event of impending dam distress. Take precautions to insure the emergency spillway is not obstructed by future road maintenance. Monitoring of observation wells should be continued with evaluation by a geotechnical engineer as the pool level is increased toward design maximums. Repair erosion damage due to pump discharge running over upstream slope and modify procedures to avoid reoccurrences. Repair surficial sloughs on the downstream slope. Provide runoff erosion protection for the ditch drain along the downstream toe. Visit the site during and after passage of significant runoff events. Study diversion system discharge characteristics and implement modifications if required. Conduct periodic inspections of the facility at least at 5 year intervals by engineers with experience in dam design and construction.

Bob B. Gemmell

Bob B. Gemmell
Professional Engineer

PERTINENT DATA
Evaporation Pond Dam

General	
Federal I.D. No.	MT-3211
Owner/Operator	The Montana Power Company, Inc.
Date Constructed	1976
Purpose	To provide permanent storage for 10 years accumulation of Fly Ash from the coal-fired power plants, plus PMF storage reserve.
Location	NE¼, Section 29, T2N, R41E, MPM Rosebud County, Montana 2 miles NW of Colstrip, Montana 35 miles south of Forsyth, Montana Latitude 45°54' Longitude 106°39'
Watershed	Unnamed tributary of Armell's Creek.
Drainage Area	0.54 square miles
Size Classification	Intermediate
Downstream Hazard Potential	Category 1, (high)
Reservoir	
Ash (Dead) Storage at Maximum Normal Pool El. 3300 feet NGVD	2360 acre-feet
Flood Storage	550 acre-feet
Total Storage at Emergency Spillway Crest El. 3304 feet NGVD	2910 acre-feet
Surcharge Storage	924 acre-feet
Total Storage at Dam Crest El. 3308 feet NGVD	3834 acre-feet
Total storage at Dam Crest-less Ash Storage	1474 acre-feet
Normal freeboard	8.0 feet
Reservoir Level (9/4/80)	3262.3 feet NGVD
Emergency Spillway	
Type	Uncontrolled unlined earth
Crest Elevation	3304.0 feet NGVD
Crest Length	15 feet
Spillway capacity with W.S. at Dam Crest El. 3308.0 feet NGVD	625 CFS
Storage Dam Embankment	
Type	Rolled zoned earth fill w/grout curtain
Hydraulic height	70 feet toe to crest
Structural height	88 feet cutoff trench to crest
Top of dam elevation	3308.0 feet NGVD
Crest Length	1840 feet
Crest Width	20 feet
Upstream slope	1V on 3H with 15 foot Berm at el. 3260.0 feet NGVD
Downstream slope	1V on 3H

CHAPTER 1
BACKGROUND

1.1 INTRODUCTION

1.1.1 Authority and Scope

This report summarizes the Phase I inspection and evaluation of the Evaporation Pond Dam owned by The Montana Power Company.

The National Dam Inspection Act, Public Law 92-367 dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers to conduct safety inspections on non-federal dams throughout the United States. Pursuant to that authority, the Chief of Engineers issued "Recommended Guidelines for Safety Inspection of Dams" in Appendix D, Volume 1 of the U.S. Army Corps of Engineers' Report to the United States Congress on "National Program of Inspection of Dams" in May, 1975.

The recommended guidelines were prepared with the help of engineers and scientists highly experienced in dam safety from many federal and state agencies, professional engineering organizations and private engineering consulting firms. Consequently, the evaluation criteria presented in the guidelines represent the comprehensive consensus of the engineering community.

Where necessary the guidelines recommend a two-phase study procedure for investigation and evaluation of existing dam conditions so deficiencies and hazardous conditions can be readily identified and corrected. The Phase I study is:

(1) a limited investigation to assess the general safety and condition of the dam.
(2) based upon an evaluation of the available data and a visual inspection.
(3) performed to determine if any needed emergency measures and/or if additional studies, investigations and analyses are necessary or warranted.
(4) not intended to include extensive explorations, analysis or to provide detailed alternative correction recommendations.

The Phase II investigation includes all additional studies necessary to evaluate the safety of the dam. Included in Phase II, as required, should be additional visual inspections, measurements, foundation exploration and testing, material testing, hydraulic and hydrologic analyses and structural stability analysis.

The authority for the Corps of Engineers to participate in the inspection of non-federally owned dams is limited to Phase I investigations with the exception of situations of extreme emergency. In these cases the Corps may proceed with Phase II studies but only to the extent needed to answer serious questions relating to dam safety that cannot be answered otherwise. The two phases of investigations outlined above are intended only to evaluate project safety and do not encompass in scope the engineering required to perform design or corrective modification work.

Recommendations contained in this report may be for either Phase II safety analyses or detailed design study for corrective work.

The responsibility for implementation of these Phase I recommendations rests with the dam owner and the State of Montana. It should be noted that nothing contained in the National Dam Inspection Act, and action or failure to act under this Act shall be construed (1) to create liability in the United States or its officers or employees for the recovery of damage caused by such action or failure to act or (2) to relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership and operation of the dam.

1.1.2 Purpose

The purpose of the inspection and evaluation is to identify current physical and operational conditions of the dam and appurtenances; and to determine if emergency measures and/or additional studies, investigations, and analyses are needed, so that corrections can be made in a timely manner by non-federal interests.

1.1.3 Inspection

The findings and recommendations in this report were based on a review of available engineering data, records, design reports, construction drawings of the Evaporation Pond Dam and a visual inspection of the project. Design information and construction drawings were obtained from the home office of the Montana Power Company in Butte, Montana. Inspection procedures and criteria used for this report were those established by the Recommended Guidelines for the Safety Inspection of Dams. (Ref. 1)

The inspection was conducted jointly by personnel from Christian, Spring, Sielbach & Associates and Northern Testing Laboratories, Inc., subcontractors. Personnel who participated in the field inspection and contributed to this report were:

CSSA- Bob B. Gemmell, Engineer, Team Leader
Alfred Cunningham, Hydraulics/Hydrology (report only)
Les Crawford, Civil Engineer
Kent Sielbach, Surveyor

NTL- Robert Gillespie, Geotechnical Engineer (report only)
Bill Henning, Geologist
Gary Quinn, Geotechnical Engineer

MDNRC- Montana Department of Natural Resources and Conservation
Art Taylor, Dam Safety Engineer

Other personnel present and participating in the field inspection include:

MPC- The Montana Power Company Incorporated
Jayson Handl, Construction Engineer

This report has been reviewed by The Montana Power Company and the State of Montana and their written comments are enclosed in Appendix A.

1.2 DESCRIPTION OF PROJECT

1.2.1 General

a. Location, Owner and Purpose

The Evaporation Pond Dam and Diversion Dam (covered under a separate report) are located in Section 29, Township 2 North, Range 41 East, MPM, in Rosebud County, Montana about 2 miles northwest of the town of Colstrip and 35 miles south of Forsyth, Montana. The dam sites are on an unnamed tributary of Armell's Creek, which in turn is a tributary to the Yellowstone River, (Plate 1). The Federal Identification Number for the Evaporation Pond Dam is MT-3211 and for the Diversion Dam is MT-3213. The project is listed as having a high (Category 1) downstream hazard potential. Construction was completed in 1976. The project is owned and operated by the Montana Power Company.

The Evaporation Pond Dam was constructed to provide storage of 10 years of fly ash which is produced during the operation of Montana Power's coal-fired power generation units at Colstrip, Montana. The flyash is initially placed in the pond as a slurry. The slurry is decanted and the clear liquid pumped back to the power plant for reuse. The remaining flyash solidifies as evaporation occurs. The peripheral drainage area is about 100 acres.

The Diversion Dam is a part of a tributary drainage system designed to prevent floodwaters from entering the Evaporation Pond. (Plate 2) The dam is located at the southwest end and just upstream of the Evaporation Pond. A diversion channel, designated as the west drain, provides a drain from the Diversion Dam and intercepts runoff along the west and north sides of the Evaporation Pond, discharging into a natural drain in Section 20. The west drain is designed for the Probable Maximum Flood (PMF) generated by a 12-hour duration Probable Maximum Precipitation (PMP).

Another channel, designated the east drain intercepts runoff from about 156 acres around the south side of the Evaporation Pond and discharges downstream of the Evaporation Pond Dam. The east drain is designed for the 100-year flood rather than the PMF, therefore, as a precaution, the Evaporation Pond is designed to store the PMF from the area south of the pond. The above design information was taken from the Evaporation Pond Dam Design Report (Ref. 8).

b. Description of Dams and Appurtenances

The Diversion Dam which protects the Evaporation Pond Dam is a rolled zoned earth-fill structure with a hydraulic height of 44 feet. It has a drainage area of 275-acres. The dam crest is 20 feet wide and 535 feet long with a crest elevation of 3344 feet NGVD. Outflow is released to the west drain through an uncontrolled twin 60-inch-diameter pipe structure with invert at elevation 3318.5 feet NGVD. The dam is designed as a "dry" dam with a small amount of space provided in the pool below elevation 3318.5 for sediment storage.

The Evaporation Pond Dam is a rolled zoned earth-filled structure with a maximum hydraulic height of 70 feet. An earthen channel intercepts normal flows around the eastern portion of the reservoir. The uncontrolled

drainage area around the reservoir perimeter is 77 acres. An additional 200 acres would be added to the drainage area if the east drain washed out during a major flood event. The dam impounds 2360 acre-feet at maximum normal pool elevation 3300 feet NGVD and 3834 acre-feet at dam crest elevation 3308 feet NGVD. An earth emergency spillway with crest length of 15 feet is located approximately 60 feet west of the left abutment.

c. Downstream Hazard Potential

The Evaporation Pond Dam is located such that a number of mobile homes, a maintenance shop, a railroad, and the highway could be affected by a sudden breach of the dam. The Town of Colstrip is a rapidly growing community and more intensive development is anticipated immediately downstream from the Evaporation Pond. (Plate 3)

The Diversion Dam is located such that it's failure during the passage of an extreme flood event would impact on flood storage provided by the Evaporation Pond which is located immediately downstream. (Plate 2) For this reason, Bechtel engineers designed the Diversion Dam storage and discharge capacity for safe passage of the PMF resulting from a 12-hour PMP, producing about 19.9 inches of runoff from the contributing 275 acre drainage area above the dam. (Ref. 8) Therefore, under normal operating conditions the dam has little downstream hazard potential. However, the hazard potential to the Evaporation Pond Dam is significantly increased during the passage of flood events approaching the 72-hour PMF. For this reason an assessment of the Diversion Dam's hydraulic capabilities and stability was made during the routing of the 72-hour PMF, selected as the Spillway Design Flood for this project. The inspection results for the Diversion Dam are presented in a separate report. However, it was determined that the Diversion Dam would pass the PMF safely and conformed to the Recommended Guidelines. Therefore, the drainage area above the Diversion Dam did not contribute to the 72-hour PMF developed for this report.

On the basis of this information and in accordance with the recommended guidelines, the Evaporation Pond Dam size is intermediate, and the project's downstream hazard potential is high (Category 1).

1.2.2 Regional Geology

The dam is located within the Northern Powder River Basin. The major geologic units within the Basin consist of late Cretaceous Marine deposits and continental deposits of late Cretaceous to Holocene age.

The Cretaceous age was characterized by frequent transgressions and regressions of the large Continental Sea, possibly related during late Cretaceous time to the beginning of the Laramide Orogeny. Broad regional uplift in Central Montana is believed to have been a cause of the final withdrawal of the sea. Vast amounts of continental deposits indicative of various fluvial and lacustrine environments were then deposited. Extensive swamps existed at various periods throughout the Late Cretaceous to Eocene time, and are now represented by many coal beds of various thicknesses and lateral extent in the Hall Creek, Fort Union, and Wasatch Formation. (Ref. 2)

Fort Union sediments were deposited during the Paleocene as the Bighorn Mountains and the Black Hills began to rise, and large volumes of sediments were transported into the nearby floodplain environment of the newly formed Powder River Basin.

The upper Paleocene is represented in the depositional sequence in the basin by the Tongue River Member of the Fort Union Formation. This unit is alternating sandstone, siltstone, carbonaceous shale, coal and clinker.

Tectonic events that occurred from Late Cretaceous through Pliocene time shaped the Powder River Basin into its present structure.

By Eocene time, all major structural features of the area had been partly formed and Wasatch Formation sediments were being deposited. During early Eocene time, strata in the basin and surrounding areas were strongly folded and faulted, forming most of the present day structural features of southeastern Montana. (Ref. 7)

1.2.3 Seismicity

The project lies in Seismic Zone 1, a zone of generally minor seismic risk as per the Corps of Engineers Guidelines, with a seismic coefficient of 0.05.

Preliminary seismic mapping by Algermissen and Perkins indicates that there is a 90 percent probability that the horizontal acceleration in rock will not exceed 0.049 in a given 50-year period.

1.2.4 Site Geology

The Evaporation Pond Dam is located in a small, dissected stream valley draining into Armell's Creek, formed by down-cutting of the stream through the soft, overlying sandstone. (Ref. 7)

Shale, siltstone, sandstone, and two coal seams of the Fort Union Formation underlie the site and the surrounding area. (Ref. 10) The Rosebud coal seam has burned and baked the overlying shale and sandstone, forming "clinker," in the area of the dam. The sandstone on the right abutment has been folded, forming broad, open folds. Overburden covers much of the rock in the area of the dam, ranging in depth from a few inches on the low hills and slopes of the valley, to a maximum depth of approximately 20 feet near the right abutment. Clayey silts, with occasional lenses of sand and fine gravel comprise most of the overburden, as per the Bechtel Design Report. (Ref. 8)

The abutments and foundation rest on and are tied to the sandstone. The emergency spillway on the left abutment has been cut into and rests on the sandstone bedrock.

A normal fault cuts through the center of the valley and the dam, with the south side of the valley moving down relative to the north side. The fault is readily seen in the geologic profile, Plate No. 6, as units on the north side cannot be correlated to those on the south side. Mapping in the area done independent of our analysis shows the trace of the fault through the valley. (Ref. 11) The fault is not believed to be active.

1.2.5 Design and Construction History

The first design report was completed in December, 1975 and revised in May, 1976. Construction was during the summer and fall of 1976 with the Bechtel Corporation providing construction management services. Montana Power Company (MPC) personnel reported an uneventful construction and post-construction history. No construction or post-construction records were available.

CHAPTER 2
INSPECTION AND RECORDS EVALUATION

2.1 HYDRAULICS AND STRUCTURES

General

The Evaporation Pond is designed to provide storage for flyash which is produced by the operation of the coal-fired power units. The flyash is initially pumped into the pond through a pipeline as a slurry. At present a temporary dam constructed of bottom ash is located in the reservoir and the slurry is pumped into the impoundment formed by the temporary flyash dam. Clear liquid from the decanted slurry is released to storage behind the Evaporation Pond Dam and subsequently pumped back to the power plant for reuse. There is no outlet works for the Evaporation Pond Dam. The maximum planned elevation of stored flyash is 3300.0 feet NGVD.

2.1.1 Emergency Spillway

The emergency spillway for the Evaporation Pond Dam is excavated through broken sandstone material in the left abutment. (Plate 4). The spillway is unlined and has no grass cover on the bottom or sides. (Photo 6) The control section consists of an earth weir located near the axis of the dam embankment, with a crest elevation of 3304.0 feet NGVD. (Plate 7) This elevation is based on levels surveyed at the time of the site visit using known elevation 3308.9 feet NGVD for the top of a concrete base on the pump station located near the center of the dam. The crest of the emergency spillway is 4 feet below the dam crest elevation 3308.0 feet NGVD. The approach channel has an adverse slope of .02 and the exit channel has a slope of approximately 0.05. At the control section, the crest width is about 15 feet with 1V on 2.5H side slopes. Prolonged spillway flows would erode the exit channel. However, this should not endanger the dam embankment which is more than 50 feet to the right or east. It is our estimation that flows during the passage of the PMF would erode the channel but not cause irrepairable damage.

The discharge rating curve (Plate 8) for the emergency spillway was developed by assuming that critical depth occurs at the control section. (Ref. 6) Friction loss in the short approach channel was assumed to be negligible. The maximum discharge capacity of the spillway with the reservoir at dam crest, elevation 3308.0 feet NGVD, was estimated at 625 c.f.s.

2.1.2. Freeboard

The reservoir water surface was at elevation 3262.3 feet NGVD at the time of the site visit, 45.7 feet below the top of the dam. Maximum elevation planned for the flyash slurry is 3300.0 feet NGVD, 8 feet below the top of the dam. Flood routings (see paragraph 2.2.4) indicate that the maximum pool elevation attained during the estimated PMF developed for this study is 3306.6 feet NGVD resulting in a freeboard of 1.4 feet. Wind generated waves were estimated to be less than 2.5 feet. Freeboard for normal pool operation is adequate.

2.2 HYDROLOGY

2.2.1 Physiography and Climatology

The Evaporation Pond Dam is located in NW¼, Section 29, T2N, R41E approximately 2 miles NW of Colstrip, Montana (latitude 45° 54', longitude 106° 39'). Purpose of the structure is to provide permanent storage for 10 years accumulation of Flyash from coal-fired power plants plus provide flood storage sufficient to protect against the probable maximum flood. The Evaporation Pond is located on an unnamed tributary of Stocker Creek which is a tributary of Armells Creek. This region is part of the great plains of Montana and is characterized by flat, treeless expanses and large gently rolling hills.

Climate in this region is considered "Continental" and therefore is typical for the interior of a large land area. (Ref. 3) Weather in this region is highly variable with rapid changes brought on by the invasion of large air masses from the Gulf of Mexico, the South and Southwest, the North Pacific Ocean, and Polar regions. Montana is in the Westerly wind belt throughout the year with the result that much of its weather comes from the West Coast and the Gulf of Alaska. Temperatures for this location range from highs in the upper 90's to extreme lows of about minus 30°F. The average "freeze-free" season is about 120 days ranging from about mid-May to mid-September. Average annual precipitation is about 12 to 16 inches with locally heavy amounts occurring from summer thunderstorms. Annual lake evaporation at this site is about 49 inches.

2.2.2 Reservoir Storage and Spillway Discharge

The Evaporation Pond has a maximum storage capacity of 3834 acre-feet at top of dam elevation (El. 3308 ft. NGVD) and a storage of 2910 acre-feet at spillway crest elevation (El. 3304 ft. NGVD). Surcharge storage available for flood routing is 924 acre-feet. The spillway for this structure consists of an uncontrolled, unlined earth channel with a 15' bottom width. Maximum spillway capacity is 625 c.f.s. when the water level is at top of dam.

2.2.3 Estimated Probable Maximum Flood (PMF)

As with the Diversion Dam, discussed in a separate report, Bechtel engineers developed a flood for Evaporation Pond resulting from the 12-hour duration PMP. "The PMP volume draining to the reservoir is the sum of the runoff from the periphery area plus the runoff from the east channel tributary areas plus the direct rainfall incident on the reservoir surface. The PMF volume was calculated to be 550 acre-feet. This total is a conservative estimate of the largest possible PMF flood volume that could drain to the reservoir. In line with this assumption, storage capacity for the PMF is reserved between El. 3300, the maximum normal pool and El. 3304, the emergency spillway crest. In the event that the PMF was proceeded by a 100-year flood, the total drainage into the reservoir would be 592 acre-feet. Disregarding the spillway flows which would occur above El. 3304 (emergency spillway crest elevation), the maximum flood pool resulting from the 592 acre-foot inflow would be at El. 3304.9. This would leave 3.1 feet of freeboard below the dam crest, El. 3308". The above quotation was taken from pages 14 and 15 of the Bechtel Design Report (Ref. 8).

Although the spillway design flood developed and routed by Bechtel appears to be adequately conservative, an independent PMF representative of the most severe combination of meteorologic and hydrologic conditions reasonably possible in the region was developed for this dam safety study in accordance with the recommended guidelines (Ref. 1).

This estimated PMF for the Evaporation Pond was developed using the HEC-1 Hydrograph-Dam Safety Computer Program (Ref. 4). Primary input to the program consisted of the 72-hour probable maximum precipitation (PMP) which was obtained for the site from Ref. 9. The 24-hour 10 sq. mile PMP value was found to be 25.0 inches which served as the basis for computing PMP values for storm durations of 1, 2, 3, 4, 5, 6, 12, 48, and 72-hours. These PMP values were used to plot a Depth-Duration curve for the 72-hour storm period which was subsequently used to determine one-hour incremental PMP values. These one-hour PMP values, after being arranged in their critical sequence in accordance with Ref. 5, were further subdivided into 10-minute intervals and used as input to the HEC-1 program. The total precipitation for the 72-hour period was 28.25 inches with a maximum hourly value of 13.06 inches.

The Evaporation Pond drainage area used for this routing includes the reservoir and its periphery as well as the area controlled by the east drain since it is anticipated the east drain embankments would wash out during a PMF. The area above the Diversion Dam is excluded from this analysis as it was for the design study. A more complete description of the drainage area and the diversion systems is presented in paragraph 1.2.1. Because the drainage area for the Evaporation Pond is extremely small (conservatively estimated at .54 sq. miles) it is unreasonable to use conventional formulas to estimate a time of concentration for overland flow. Instead it was assumed that the total rainfall during each 10 minute storm interval (i.e. the total rainfall occurring on .54 sq. miles) enters the reservoir during that same time interval. Consequently, the unit hydrograph used here consists of a single value which converts rainfall for each 10 minute interval into reservoir inflow (cfs).

Combination of the critical PMP sequence with the unit hydrograph ordinate resulted in the PMF inflow hydrograph to the Evaporation Pond Dam reservoir. It was assumed that frozen soil conditions prevailed during the entire PMP thereby resulting in zero infiltration loss. The total PMF inflow volume was 767 acre-feet.

2.2.4 Flood Routing

As previously discussed, in paragraph 2.2.3, development and routing of the spillway design flood by Bechtel engineers, shows that their flood (12-hour PMP) is contained in the reservoir with 3.1 feet of freeboard.

Subsequent routing of the most severe flood event (72-hour PMP) was made to determine project performance under this extreme condition. Routing was accomplished using the HEC-1 computer program. The initial reservoir surface elevation was assumed to be at the crest of the emergency spillway (El. 3304 ft. NGVD) at the onset of the PMF. Initial inflow as well as infiltration were assumed to be zero. The modified puls method was used for reservoir routing.

Routing studies indicated that the Evaporation Pond successfully controlled the estimated PMF. Maximum reservoir water surface elevation during the routing was found to be 3306.7 feet NGVD compared to top of dam elevation 3308.0 feet NGVD. Maximum spillway outflow was 294 c.f.s. compared with maximum spillway capacity of 620 c.f.s.

2.3 GEOTECHNICAL EVALUATION

The "Design Report for the Colstrip Project, Montana, Evaporation Dam," (Ref. 8) dated December, 1975 and revised May, 1976, prepared by the Bechtel Power Corporation, (Ref. 8) was made available by the Montana Power Company. Selected final construction drawings were also made available upon request for use in the preparation of this inspection report.

The Evaporation Pond serves as a settling basin and storage facility for flyash produced at, and pumped in a slurry from the Colstrip power plant. Following settling of the flyash, the liquid medium is piped back to the power plant for reuse. A temporary flyash dam that provides a primary settling basin for the slurry prior to decanting into the evaporation pond is located immediately upstream from the pond.

2.3.1 Dam Embankment

The Design Report indicates the dam to be a zoned earthfill embankment with a crest length of 1840 feet and a maximum height of 70 feet above the original ground surface. A crest width of 20 feet was designed to handle construction and maintenance traffic. Both upstream and downstream slopes were designed at 1V on 3H. A 15-foot-wide berm is shown on plan drawings at elevation 3260 feet. A typical cross section of the embankment is shown on Plate No. 5.

The central zone of the dam consists of an impervious core with nearly vertical walls extending to a foundation cutoff trench of similar impervious material. A shell of low permeability material surrounds the core. Slope protection consists of soil-cement above elevation 3260 feet on the upstream slope and seeded grass cover on the downstream slope. (Photos 1 and 5)

The internal drainage system is comprised of a chimney drain and an inclined drain lining the downstream face of the embankment core and foundation cutoff trench, respectively. These drains intercept seepage for transmission via a horizontal drainage blanket to a toe drain.

Sources and properties of materials proposed for use in various embankment zones were investigated by NTL in 1975, with results of the field and laboratory investigations published in the Design Report. (Ref. 8)

Materials for the core and shell zones of the embankment were to be obtained from local borrow sources. The relatively impervious core materials were predominantly low-plasticity clay-silt (CL-ML) soils, with compacted permeabilities less than one foot per year. The shell materials were silty sand (SM), sandy silt (ML), and clayey silt (CL) soils, with compacted permeabilities on the order of one to three feet per year. When subjected to triaxial shear testing, compacted samples of core and shell materials exhibited good and fair shear strengths, respectively.

Materials for the internal drainage zones were sand-gravel soils processed to meet filter and drainage requirements.

Materials suited for use as riprap on the upstream slope were not found locally. In lieu of importing suitable materials, soil-cement slope protection was used; local sandy soils were used in the mixture.

The inspection found no evidence of settlement, cracking, or misalignment along the dam crest (Photo 1). No traffic damage was observed on the crest service road. (See owner comment G in Appendix)

The upstream slope evidences no cracking, settlement, or substantial deviation from the planned slope. Pond water level prevented inspection of the berm at elevation 3260 feet. The soil-cement slope protection, with a plan thickness of 1.5 feet normal to the slope, has undergone moderate wave and runoff erosion, accounting for a loss in protective thickness estimated at less than 10 percent (Photos 2 and 3). Discharge waters from a pump station on the dam crest, near mid-dam are allowed to run over an isolated area on the lower portion of the slope. Considerable local erosion has resulted (Photo 4).

The downstream slope is generally well-covered by grasses, and shows no substantial deviation from the planned slope. The repair of some surficial sloughing was apparent near the right abutment and several minor, surficial sloughs were observed elsewhere along the slope (Photo 5). Only occasional animal burrows were noted. Minor runoff erosion rills at the abutment contacts were observed. No seepage was seen on the slope or in the abutment areas. Some runoff erosion exists on the bench above the toe drain near the middle of the dam. Runoff erosion has deepened and widened the drainage ditch downstream of the toe drain.

2.3.2 Foundation Conditions, Seepage and Drainage

The geologic profile at the dam site shown on Plate 6 was constructed using subsurface data presented in the Bechtel Design Report, and confirmed to the extent possible by our recent field observations. The field exploration from which the geologic data were gathered was conducted by NTL in 1975. Subsequent laboratory testing to determine index and engineering properties of representative foundation materials was also performed by NTL. Test results are presented in the aforementioned Design Report. (Ref. 8)

The preconstruction geologic profile along the dam axis indicates a soil overburden varying in thickness from several feet on the gently sloping valley walls forming the left abutment, to as much as 20 feet along the valley floor and near the right abutment. The overburden soils were generally loose to medium dense clayey silts and sands, randomly interspersed with firm to stiff silty and sandy clays.

The predominant sandstone bedrock underlying the site is interbedded with shale and siltstone, and is weathered, friable, and poorly to moderately cemented near the surface. Coal layers near both abutments and discontinuous, thin coal seams were encountered in the valley floor bedrock. The coal layers found near the abutment had apparently been eroded from the lower elevations of the valley floor.

Groundwater monitored during the field exploration stabilized between elevations 3203 feet and 3256 feet. Field permeability testing and water losses during drilling, however, indicated the most permeable materials at the site to be above the groundwater levels, i.e., the coal and weathered sandstone layers.

The Design Report recommended several measures to reduce pond losses and seepage toward Armell's Creek. These were:

1) A cutoff trench was to be extended into bedrock along the dam axis.

2) The foundation and abutments were to be pressure-grouted with the grout curtain in the abutment areas to extend below the coal layer.

3) Fractured bedrock zones of high-permeability exposed in the reservoir floor were to be blanketed with relatively impermeable material.

4) A well and drain system downstream of the dam was to collect any underflow passing the internal drainage system within the embankment. Collected waters were to be pumped back to the pond. This sytem was to be constructed in stages as the pond level increased.

MPC personnel report that the recommendations were implemented or in the case of #4, is planned for. At the time of inspection the toe drain area was dry. The valley drainage trench into which the toe drain discharges was viewed through the riser pipes located downstream of the embankment toe. No flow was observed, but there was some standing water.

The emergency spillway located in the left abutment is cut into weathered sandstone material. The spillway approach channel is presently slightly obstructed by the service road crossing the dam crest. (Photo 6) Road maintenance could create a flow obstruction in the future.

Thirteen groundwater monitoring and sampling wells installed during the field exploration were intended for permanent use in detecting post-construction changes in groundwater levels and quality. The scope of any present groundwater monitoring program is not known.

2.3.3 Stability

Embankment stability was analyzed by Bechtel at the most critical section of the dam, using a computer solution for the Simplified Bishop Method of slices. Stability analyses were conducted for the following three cases:

1) Steady State Seepage--both upstream and downstream slopes with maximum pool elevation (El. 3300).

2) Seismic--both upstream and downstream slopes with maximum pool elevation.

3) End of Construction--both upstream and downstream slopes. The rapid drawdown case was not evaluated.

These cases, along with their respective recommended and computed factors of safety as reported in the Bechtel Design Report, are listed as follows:

	Factor Of Safety	
	Recommended	
Upstream Slope	By Guidelines	Computed
Steady Seepage, nonseismic	1.5	2.3
Steady Seepage, seismic	1.1	1.8
End of Construction	1.25	1.3
Downstream Slope		
Steady Seepage, nonseismic	1.5	2.0
Steady Seepage, seismic	1.1	1.7
End of Construction	1.25	1.3

The strength parameters used for the stability analyses were determined from unconsolidated-undrained and consolidated-drained triaxial tests made on undisturbed foundation material samples and remolded embankment specimens. The pseudo-static earthquake loading used a seismic coefficient of 0.05g.

2.4 PROJECT OPERATIONS AND MAINTENANCE

2.4.1 Dam Maintenance Plan

Project maintenance inspections have been made on a regular basis by MPC personnel. However, no records or written maintenance plans were available for review.

2.4.2 Reservoir

Maximum planned pool elevation is 3300.0 feet. Pool elevation is determined by pumps controlling the inflow of flyash slurry and outflow of decanted water. No records of reservoir operations were available for review.

2.4.3 Warning System

There is no downstream warning plan in case of impending dam distress.

CHAPTER 3
FINDINGS AND RECOMMENDATIONS

3.1 FINDINGS

Visual inspection of the Evaporation Pond Dam supplemented by evaluation of available design reports and engineering data, and analysis of the project in terms of the recommended guidelines performance standards, resulted in the following findings.

3.1.1 Size, Hazard Potential and Safety Evaluations

The 70 foot high Evaporation Pond Dam will eventually impound 2360 acre-feet of flyash from MPC's power plants at Colstrip. The top 8 feet of the dam is reserved for flood control and will impound an additional 1474 acre-feet of flood waters.

The Colstrip townsite expansion now underway will enlarge the community from less than 2,000 to an estimated 8,000 population. The current design plan calls for more development of the area immediately downstream of the Evaporation Pond Dam, in addition to the existing homes and businesses. (Plate 3) A failure of this project could endanger many lives and could cause much property damage. This intermediate sized project has a high downstream hazard potential (Category 1).

Routing studies done for this study show that the dam can control the full estimated PMF developed for this site. Therefore, the flood storage capacity and discharge capabilities of the Evaporation Pond Dam are adequate and conform to COE guidelines (Ref. 1) and no further hydrologic investigation is recommended. Based on our visual inspection and review of design criteria the embankment appears to be adequately stable and conforms to the recommended guidelines.

3.1.2 Emergency Spillway

Visual inspection of the emergency spillway shows it to be in good condition. Road maintenance could tend to obstruct the approach channel. Some minor erosion has occurred on the cut slopes of the downstream channel. (Plate 6)

3.1.3 Spillway and Reservoir Capacity

The reservoir has a maximum storage of approximately 3834 acre-feet at dam crest, elevation 3308.0 feet NGVD. Since the dam is designed for permanent storage of 2360 acre-feet of flyash at elevation 3300.0 feet NGVD, the eventual flood storage will be 550 acre-feet below emergency spillway crest elevation 3304.0 feet. The emergency spillway has an estimated capacity of 625 c.f.s. with reservoir level at the top of dam. Surcharge storage available between the emergency spillway crest and dam crest is approximately 924 acre-feet.

3.1.4 Dam Embankment

No cracking, differential movements, or misalignments were observed along the dam crest, slopes, or abutment contacts. (Photo 1) Only minor surficial sloughing was seen at isolated locations on the downstream slope. (Plate 5) No seepage was encountered. However, reservoir levels attained to date are well below design levels.

The soil-cement protection of the upstream slope has undergone minor runoff and wave erosion damage. (Photos 2 and 3) A localized area of substantial erosion has occurred near pond level on the upstream slope due to pump discharge. (Photo 4)

The service road along the dam crest presently slightly obstructs the entrance channel to the emergency spillway at the left abutment. However, it does not prevent spillway usage at the maximum flood pool elevation.

3.1.5 Stability

The design analysis procedure and criteria for stability of the dam embankment used by Bechtel are in substantial agreement with the COE Recommended Guidelines for Safety Inspection of Dams (Ref. 1). The resulting factors of safety meet or exceed the criteria. The seismic coefficient used in the pseudo-static earthquake loading analysis complies with COE recommendations for Seismic Zone 1.

3.1.6 Operations and Maintenance

Because of the slurry pumping system, the dam is visited very frequently by maintenance personnel. However, it would be advisable to visit the site during and after the passage of significant runoff producing flood events. No published O & M schedule or inspection records were available for review.

3.2 RECOMMENDATIONS

The dam in its present condition exhibits the capability to perform its design functions in a reasonably safe manner. The intent of these report recommendations is to improve project appearances and prevent further erosion damage. Erosion damage is considered minor at present.

1. Insure the emergency spillway is not obstructed by future road maintenance.

2. Monitoring of observation wells should be continued with evaluation by a geotechnical engineer as the pool level is increased toward the elevation of the potentially more permeable layers in the abutments. Consider the installation and monitoring of piezometers, especially as the reservoir fills to designed levels.

3. Repair erosion damage due to pump discharge running over upstream slope and modify procedures to avoid reoccurrences.

4. Repair surficial sloughs on the downstream slope.

5. Provide runoff erosion protection for the ditch drain along the downstream toe.

6. Visit the site during and after passage of significant runoff events. Study diversion system discharge characteristics and implement modifications if required.

7. Conduct periodic inspections of the facility at least at 5 year intervals by engineers with experience in dam design and construction.

8. Implement and periodically test a warning plan to warn downstream residents in the event of dam distress.

REFERENCES

1. U.S. Army Corps of Engineers, Office the Chief of Engineers Report to the U.S. Congress, National Program of Inspection of Dams, Vol. 1, Appendix D, "Recommended Guidelines for Safety Inspection of Dams," Washington, D.C.; Department of the Army, May 1975.

2. William C. Alden, Physiography and Glacial Geology of Western Montana and Adjacent Areas, Geological Survey Paper 231, 1953.

3. G. J. Wicks, The Framework Report, Montana Department of Natural Resources and Conservation, Water Resources Division, Vol. 1, 1976.

4. U.S. Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package Dam Safety Investigations, Davis CA, Sept. 1978.

5. U.S. Weather Bureau, Hydrometerological Report No. 43 - Probable Maximum Precipitation Northwest United States, November, 1966, Washington D.C.

6. U.S. Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, 1972.

7. Geology and Water-Yielding Characteristics of Rocks of the Northern Power River Basin, Southeastern Montana, by Barney D. Lewis and Robert S. Roberts. Map I-847-D USGS 1978.

8. Bechtel Power Corp., "Design Report for the Colstrip Project, Montana, Evaporation Dam," 1974, San Francisco, CA.

9. National Weather Service, "Interm All-Season Probable Maximum Precipitation Estimates, Missouri River Basin, West of 105th Meridian," Jan. 1980.

10. Hardin 1° X 2° Geologic Map, Montana Bureau of Mines and Geology, Bob Bergantino, 1977.

11. "Montana Bureau of Mines and Geology, Bulletin 91, Quantity and Reserves of Strippable Coal; Selected Deposits Southeast Montana, R.E. Matson, J. W. Blumer, 1973.

PHOTOS

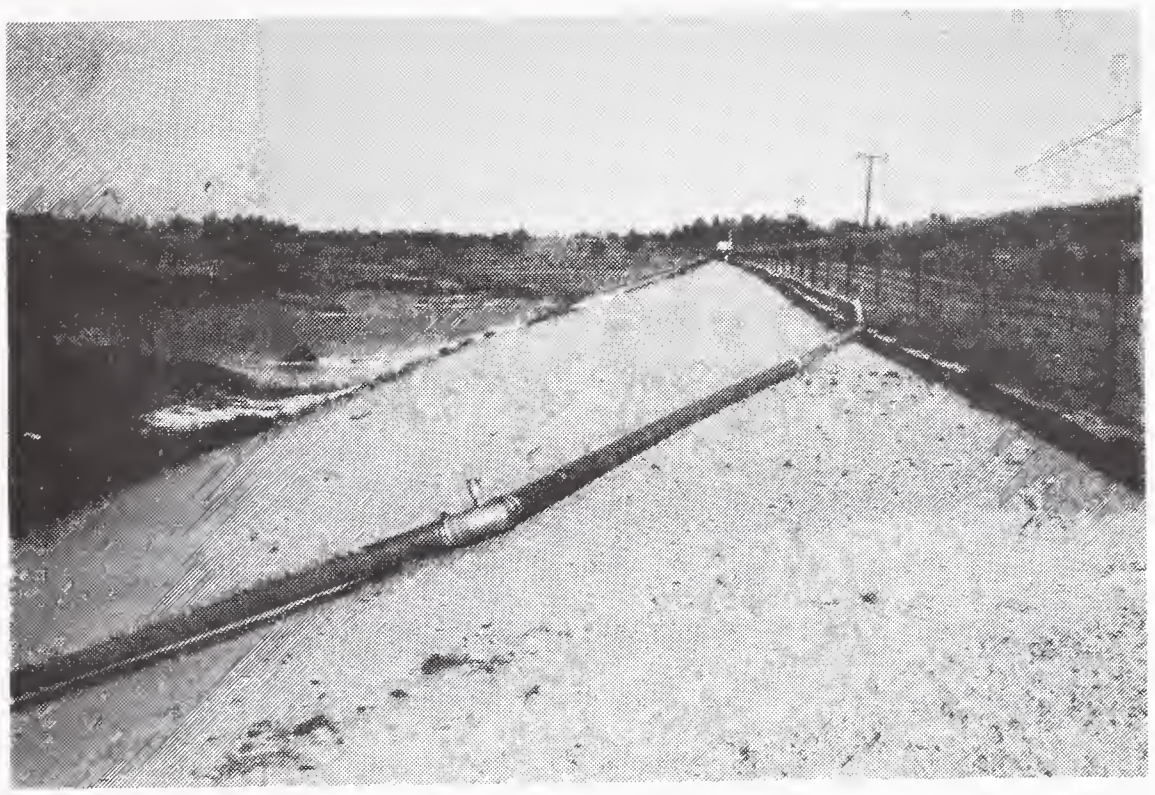


PHOTO 1

Upstream Slope

Note: Slurry Pump Barge in Pond

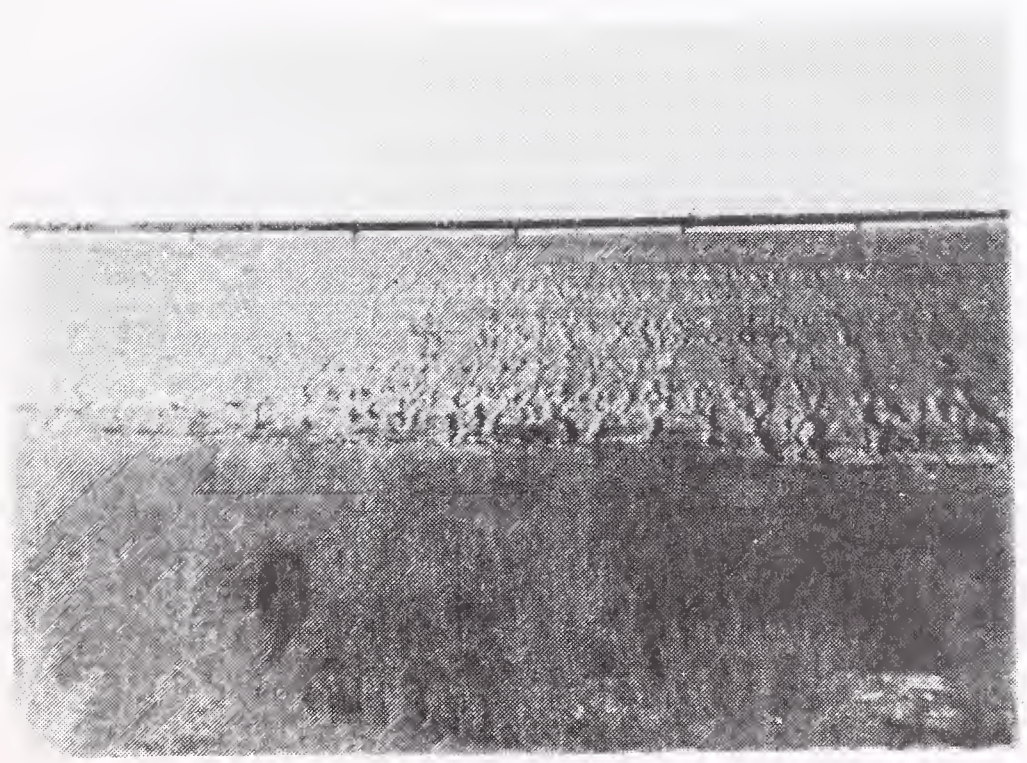


PHOTO 2

Runoff Erosion on Upstream Slope

PHOTO 3

Wave Erosion

PHOTO 4

Erosion Caused by Pipe Discharge

PHOTO 5

Downstream Slope & Right Abutment

Note: Minor Slough In Front of Man

PHOTO 6

Emergency Spillway Entrance

Note How Road Maintenance Partially Obstructs

PLATES

MONTANA

PROJECT LOCATION

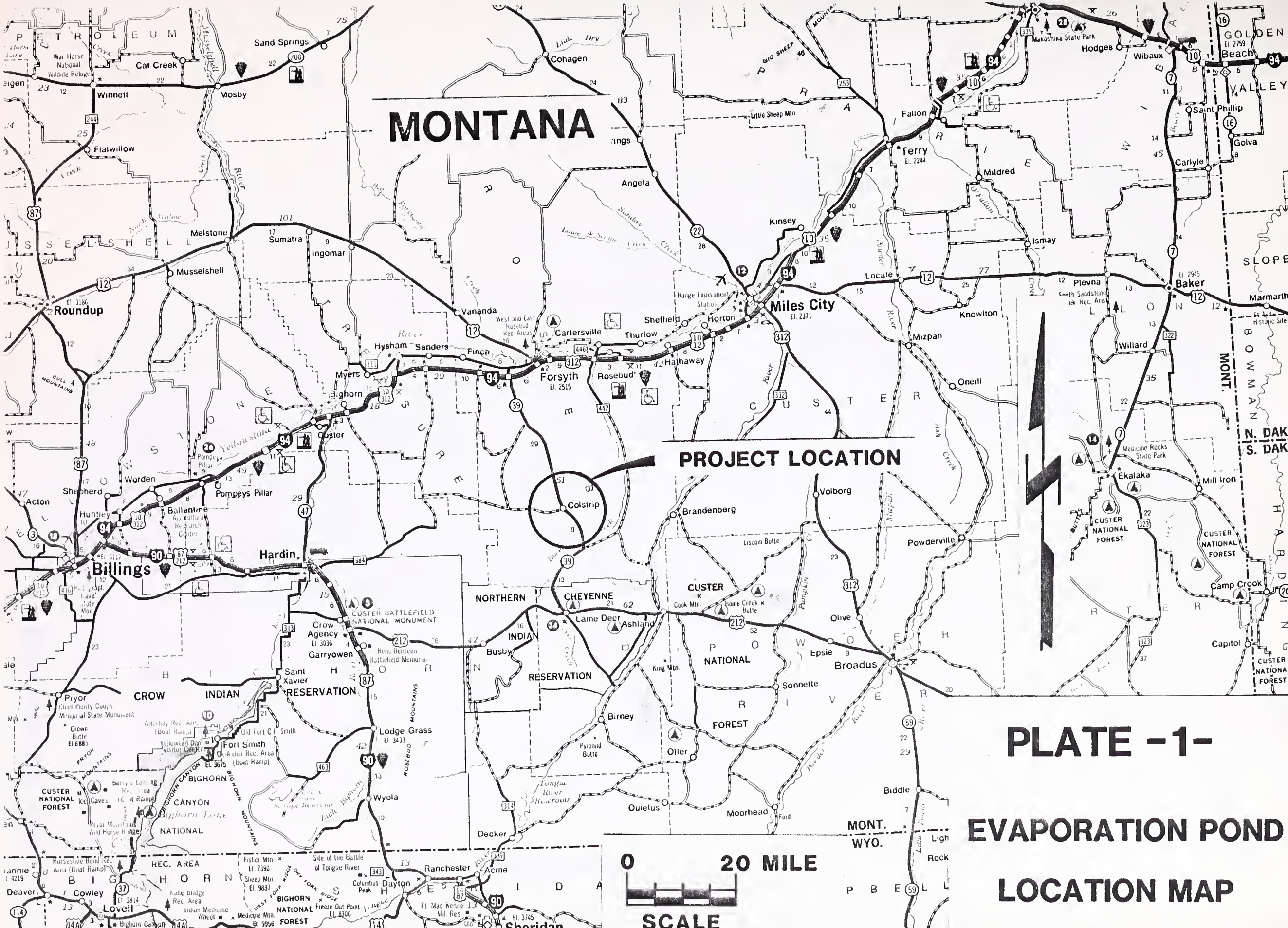


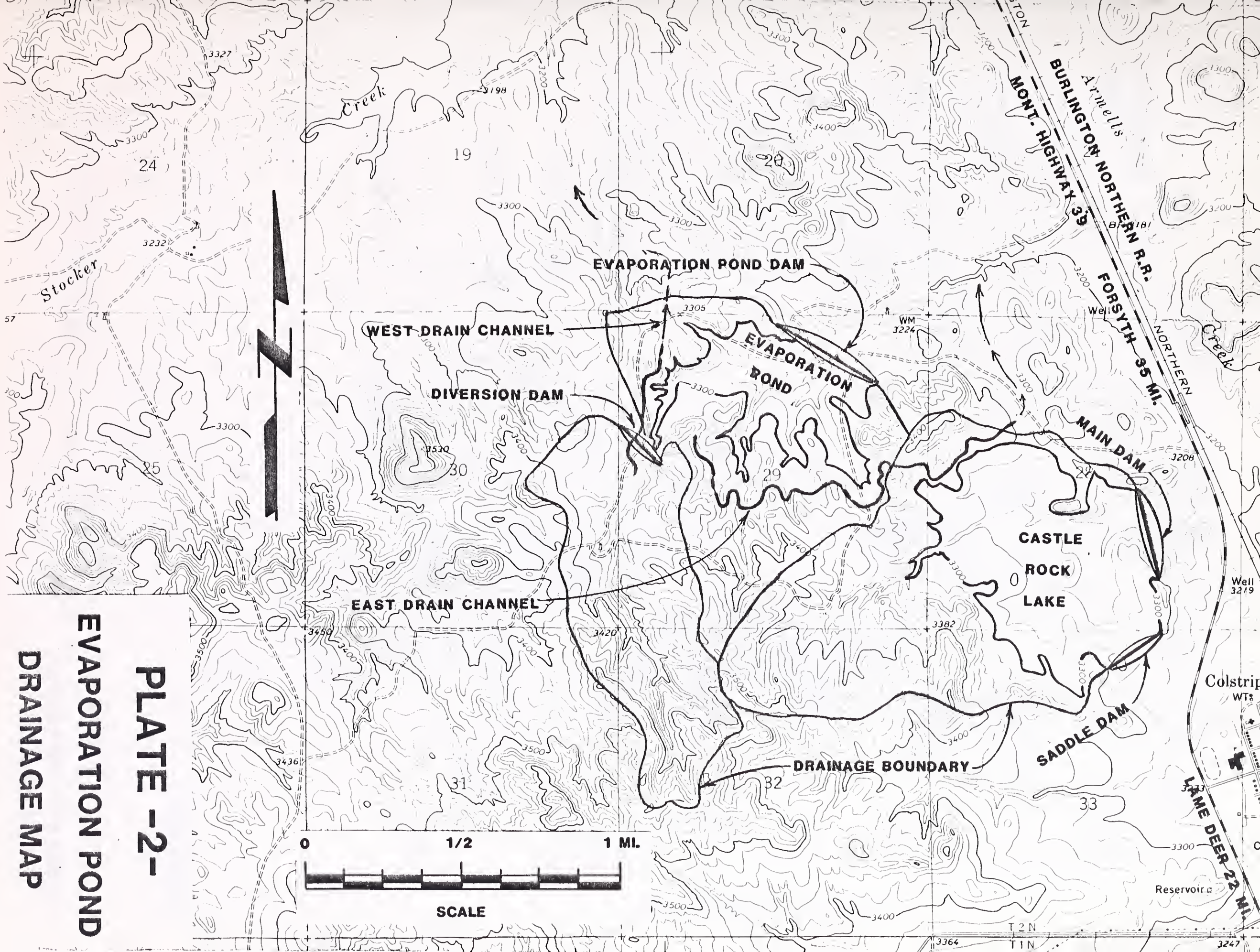
PLATE -1-

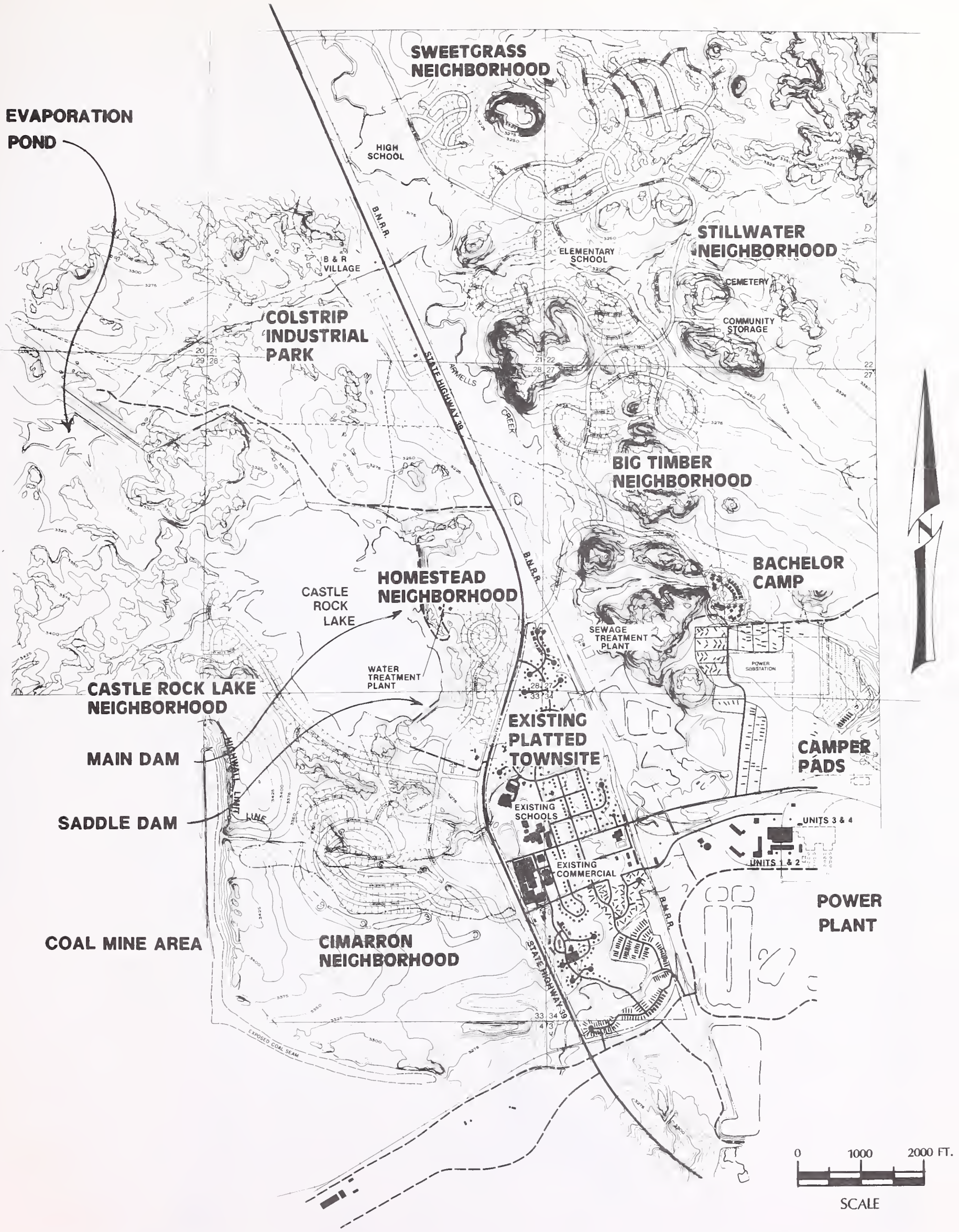
EVAPORATION POND LOCATION MAP

PLATE -2-

EVAPORATION POND

DRAINAGE MAP



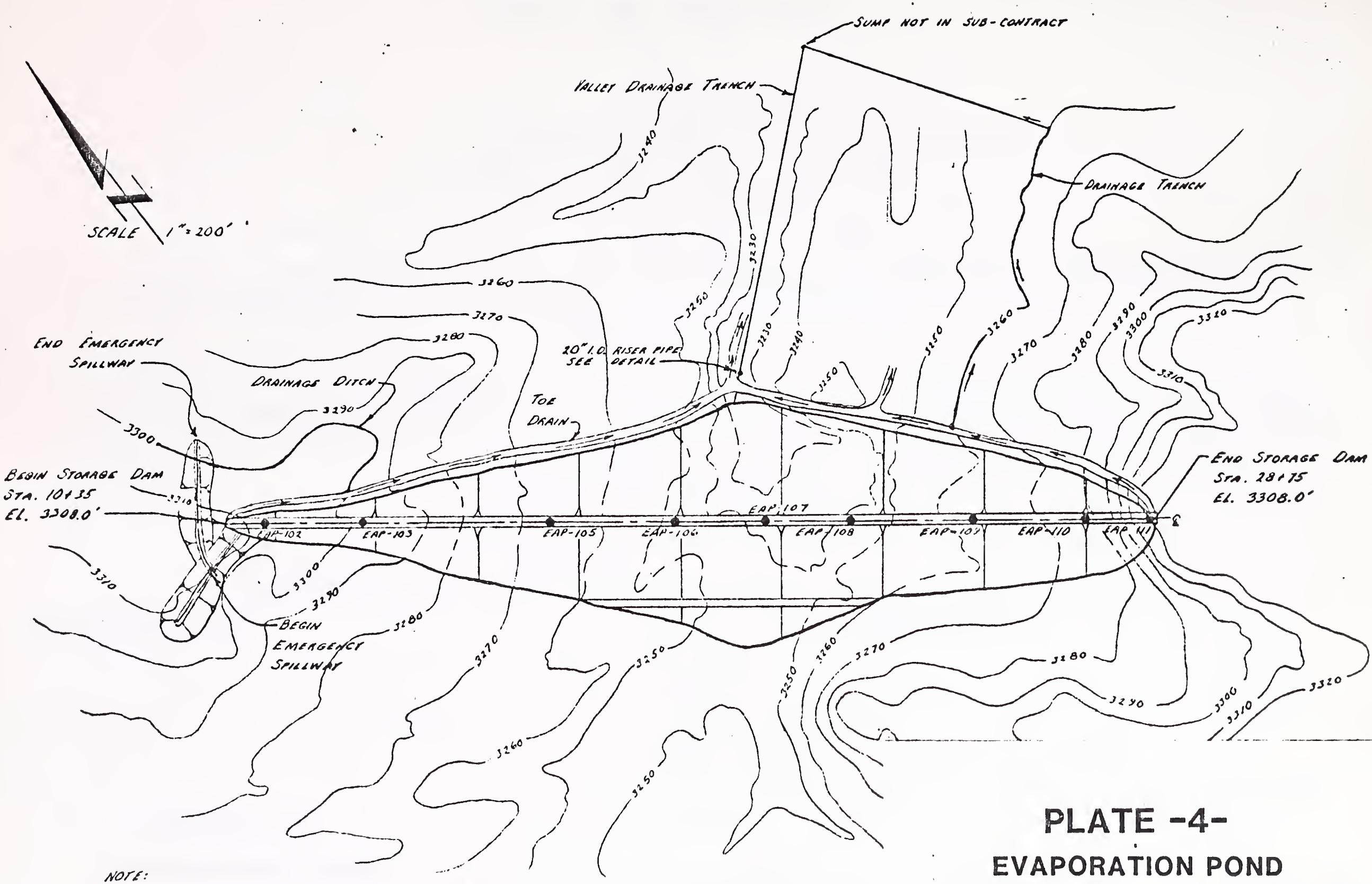


NOTE: COLSTRIP EXPANSION UNDER CONSTRUCTION 1979 - 1981

PLATE -3-

COLSTRIP TOWNSITE EXPANSION

PLAN OF STORAGE DAM



NOTE:
ALL INFORMATION ON THIS PLATE HAS BEEN TAKEN FROM THE COLSTRIP PROJECT, MONTANA, EVAPORATION POND DESIGN REPORT, PREPARED BY THE BECTEL POWER CORPORATION DECEMBER, 1975 - REVISED MAY, 1976

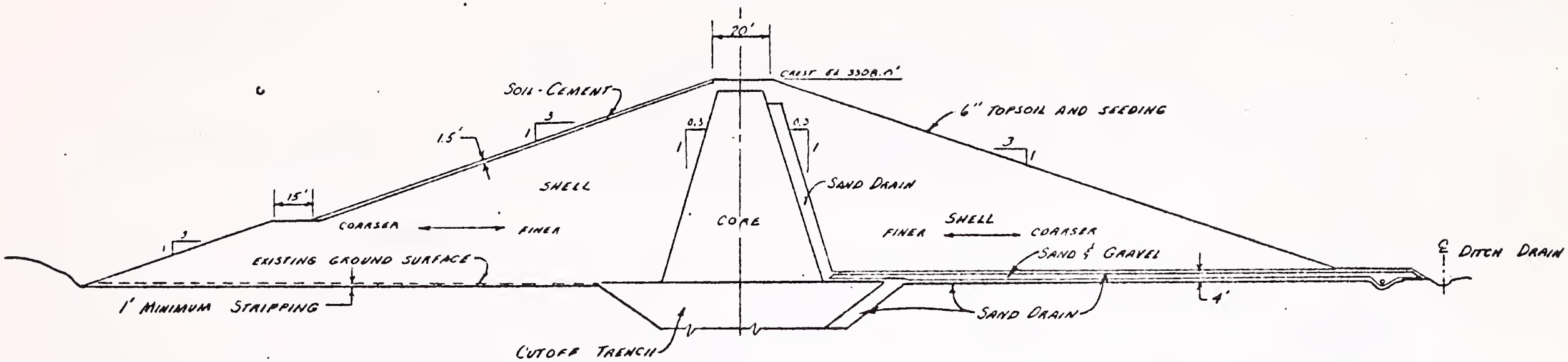
PLATE -4-

EVAPORATION POND

DAM - PLAN

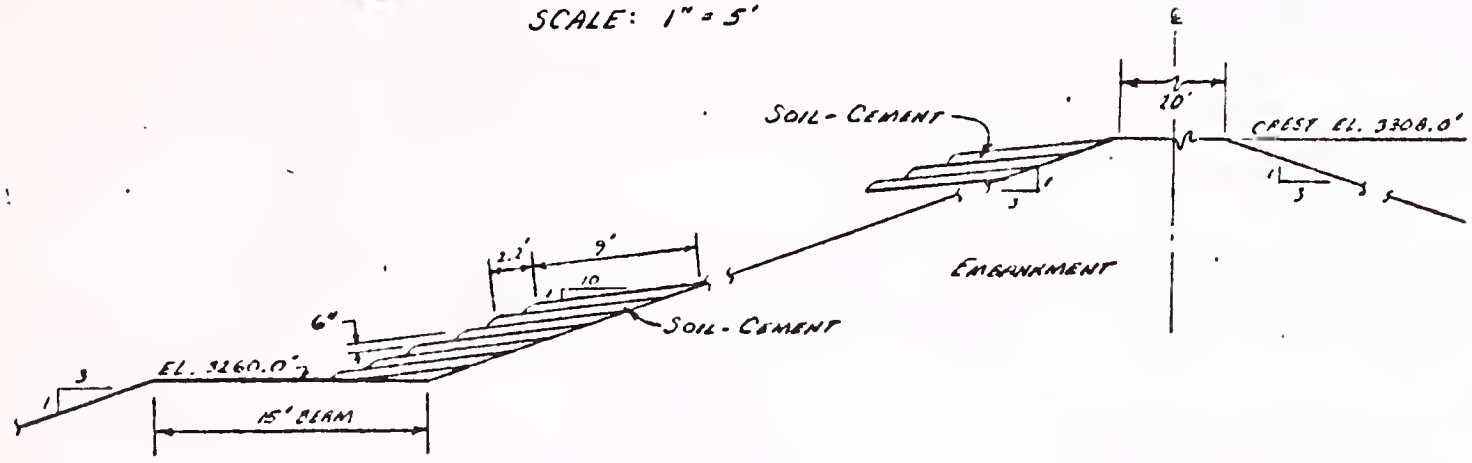
STORAGE DAM EMBANKMENT

SCALE: 1" = 40'



SOIL-CEMENT DETAIL

SCALE: 1" = 5'



NOTE:
ALL INFORMATION ON THIS PLATE HAS BEEN TAKEN FROM THE COLSTRIP PROJECT, MONTANA, EVAPORATION POND DESIGN REPORT, PREPARED BY THE BECHTEL POWER CORPORATION. DECEMBER, 1975 - REVISED MAY, 1976

TOE DRAIN DETAIL

SCALE: 1" = 5'

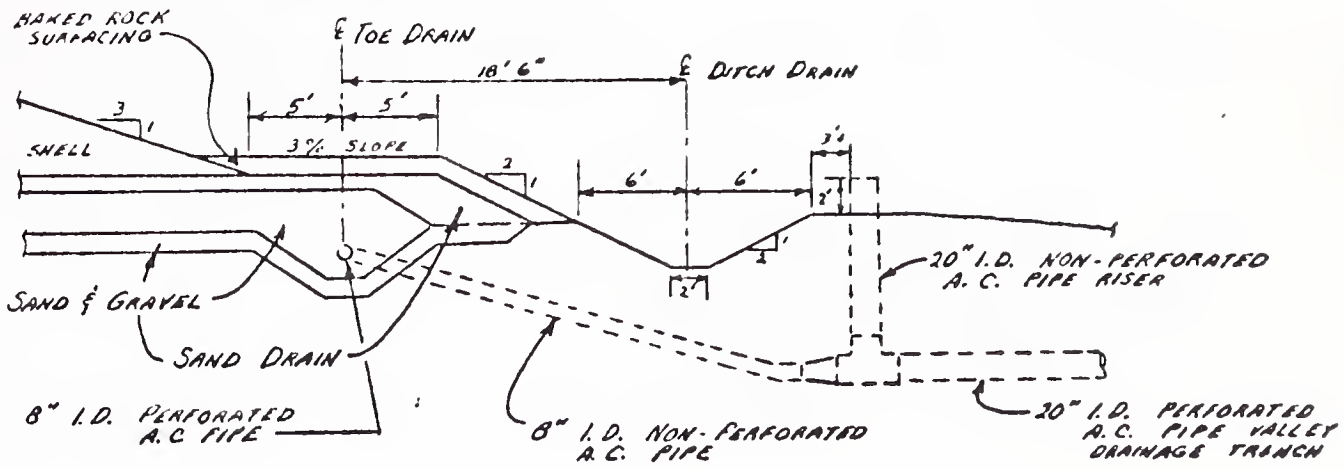
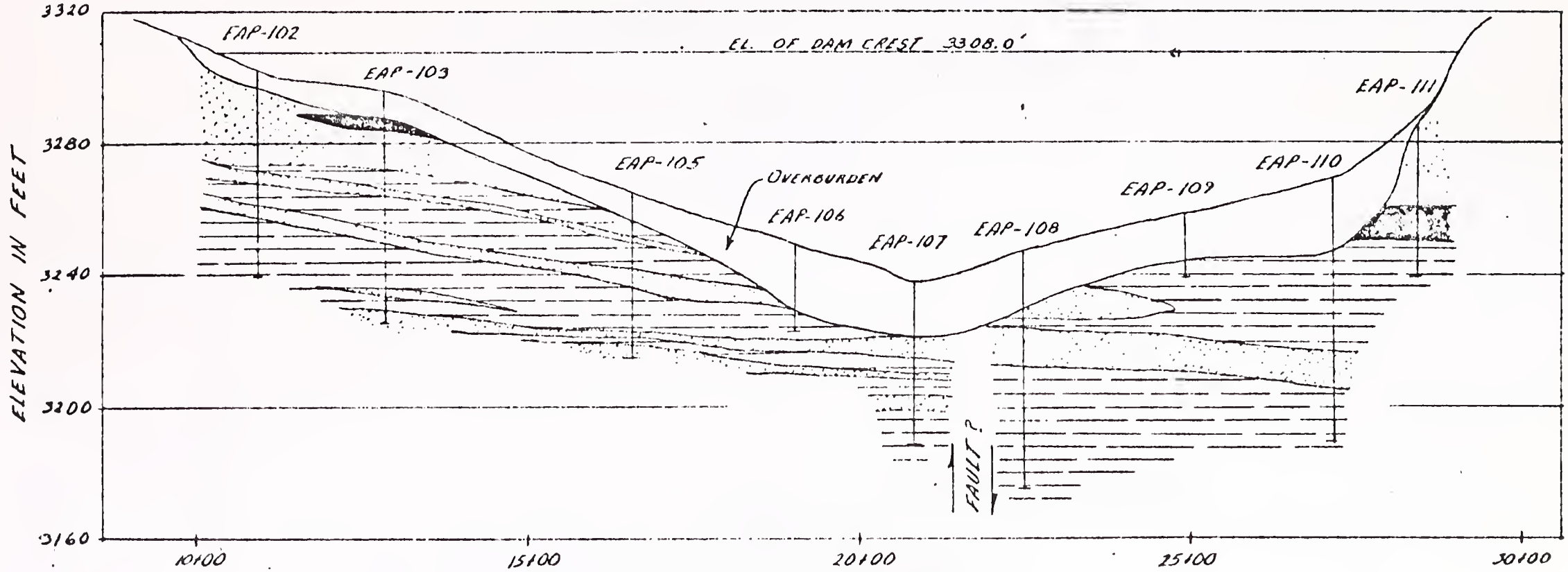


PLATE 5-
EVAPORATION POND
DAM - SECTIONS

PROFILE ALONG AXIS OF DAM

SCALE: HORIZ. 1" = 200'
VERT. 1" = 40'

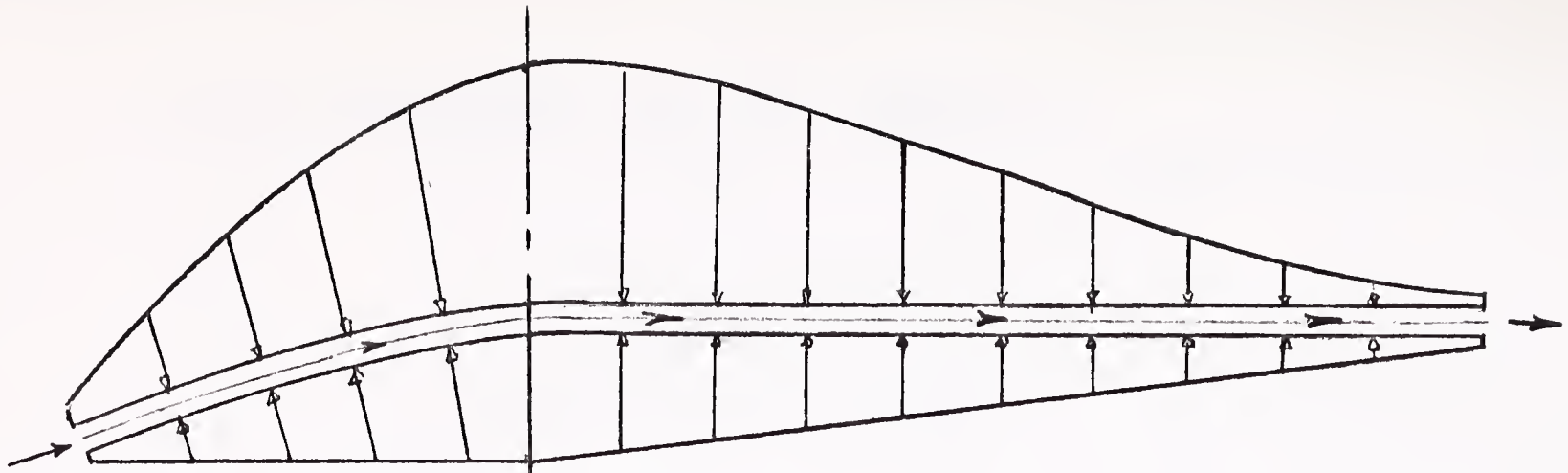


LEGEND

- OVERBURDEN
- SANDSTONE
- COAL
- SHALE

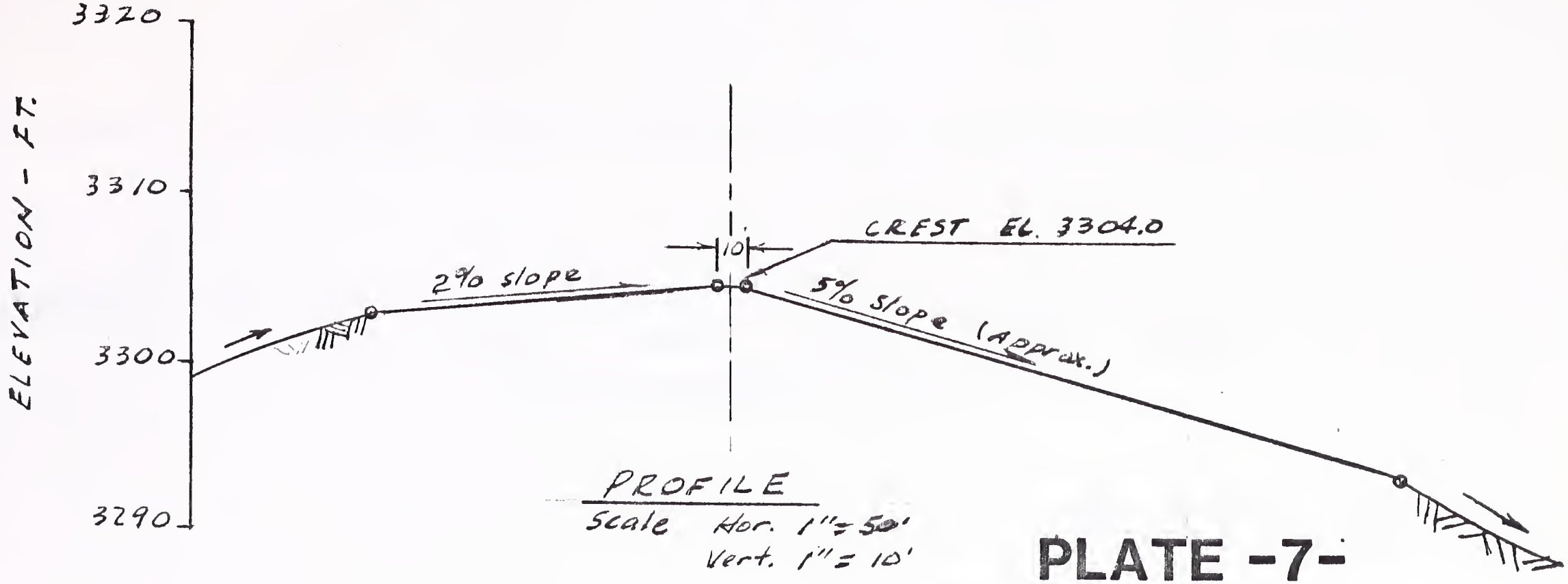
NOTE:
ALL INFORMATION ON THIS PLATE HAS BEEN TAKEN FROM THE COLSTRIP PROJECT, MONTANA, EVAPORATION POND DESIGN REPORT, PREPARED BY THE BECHTEL POWER CORPORATION
DECEMBER, 1975 - REVISED MAY, 1976

PLATE -6-
EVAPORATION POND
DAM - PROFILE



PLAN

Scale 1" = 40'



PROFILE

Scale Hor. 1" = 50'
Vert. 1" = 10'

PLATE -7-

EVAPORATION POND
EMERGENCY SPILLWAY
PLAN & PROFILE

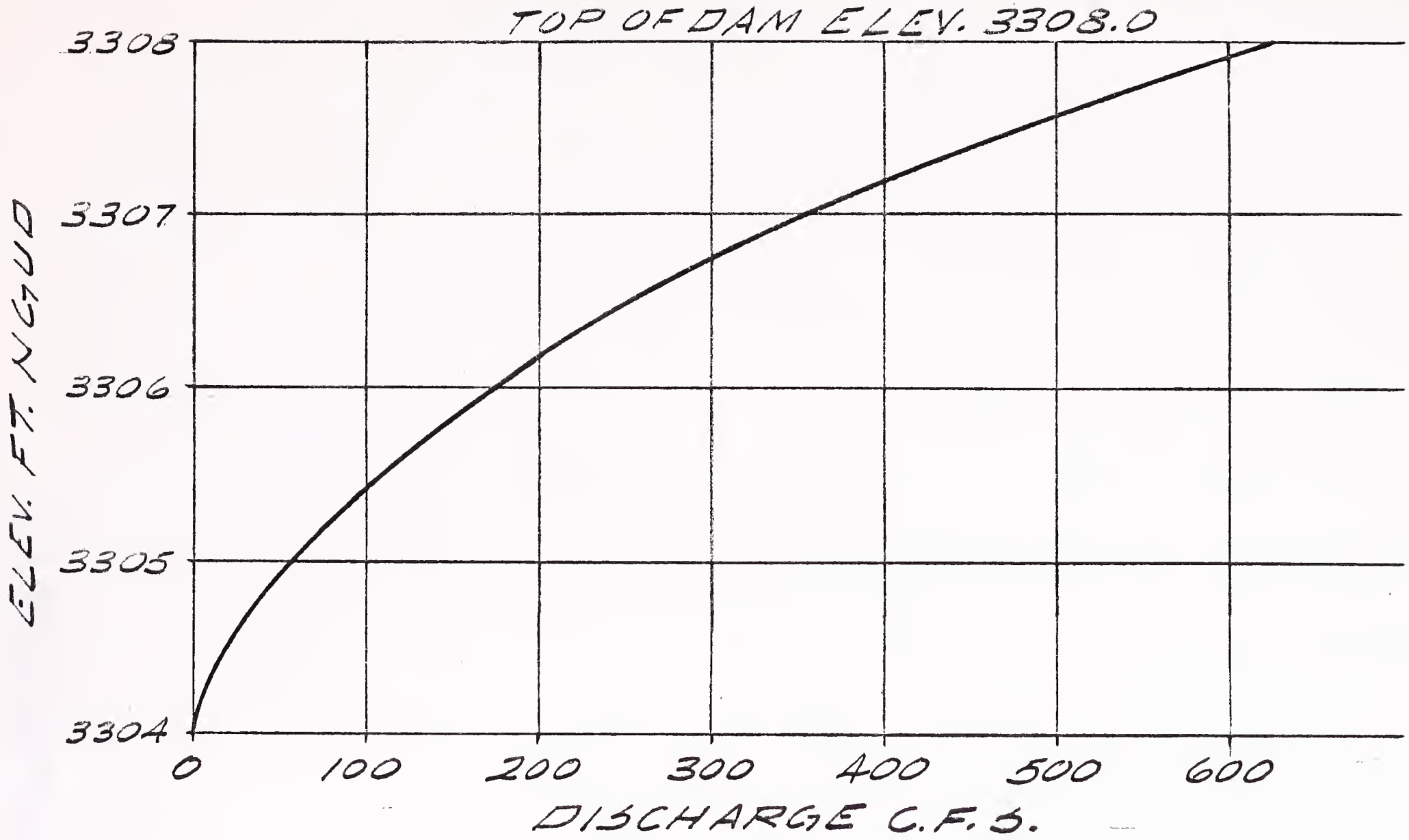


PLATE -8-

EVAPORATION POND EMERGENCY SPILLWAY RATING CURVE

CORRESPONDENCE

MONTANA POWER COMPANY mpc
GENERAL OFFICES: 40 EAST BROADWAY, BUTTE, MONTANA 59701 • TELEPHONE 406/723-5421

ROBERT J. LABRIE
VICE PRESIDENT
ENGINEERING AND TECHNOLOGY

May 26, 1981

Department Of The Army
Seattle District Corps Of Engineers
P O Box C-3755
Seattle, WA 98124

ATTN: Mr Sideny Knutson, PE
Assistant Chief
Engineering Division

RE : Colstrip Units #1 and #2
File: Design General, Ash Pond Studies
Evaporation Pond and Diversion Dams
Phase I - Inspection Report
National Dam Safety Program

Gentlemen:

We have reviewed the above referenced reports transmitted to us per your letter of April 28, 1981, and have the following comments, first concerning the Evaporation Pond Dam and finally the Diversion Dam.

Evaporation Pond Dam

A. In the Pertinent Data and various other sections of the report it is incorrectly stated that the Evaporation Pond Dam (and Diversion Dam) are located on an unnamed tributary of Stocker Creek, a tributary of Armell's Creek. The dams are, in fact, located on an unnamed tributary of Armell's Creek; Stocker Creek is not involved, except as the outlet for the West Drain Channel.

B. The report states that intensive community development is planned "immediately downstream" of the Evaporation Pond. In actuality, a Second Stage Evaporation Pond and Dam, similar in design and size to the existing

Evaporation Pond and Dam, are planned immediately downstream of the Evaporation Pond. This new pond and dam are scheduled to begin construction in the spring of 1983 and be complete in the fall of 1984. The aforementioned community development will be located immediately downstream of the Second Stage Evaporation Pond.

C. On Page 12, Section 2.1, it is stated that a temporary dam constructed of bottom ash has been constructed in the reservoir. The wording here and in Section 2.3 on Page 18, may lead a reader to believe that this temporary dam is constructed of fly ash. We wish to emphasize that it is constructed entirely of bottom ash.

D. In Section 2.2.3, Page 15, the following sentence should be inserted in the quote from the "Bechtel Design Report" between the third and fourth sentence: "It is assumed that in the case of the PMF, the east channel will be incapable of diverting any of the runoff around the reservoir."

E. We wish to point out that an observation well monitoring program has been ongoing since we began filling the pond and we plan to continue the program throughout the life of the project.

F. The intent of the inspection was to determine if the dam constitutes a hazard to human life and property. The USCE guidelines state that the engineer-in-charge will give his opinion of the significance, with regard to safety, of any deficiencies in his assessment of the dam. Recommendations 3, 4, and 5 contained in the CSSA report are not discussed in this light. In any event, The Montana Power Company will rectify these deficiencies in the course of normal maintenance.

G. In the spring of 1977 a longitudinal crack on the upstream slope of the dam was discovered. This crack was parallel to the axis of the dam, about 30 feet horizontally upsteam of the dam axis, about 200 feet long and 1-½ inches wide at its maximum. It extended vertically downward about six feet into the upstream shell zone of the dam. Bechtel Power Corporation studied the problem and released their findings and recommendations in a report entitled "Investigation of Cracking In the First Stage Evaporation Pond Dam",

dated March, 1981. Their conclusions were that the causes were a combination of differing compressibility of foundation soils and core trench fill material, swelling or collapse of soils upon saturation, shrinkage due to surface drying, or warping and tensile stresses developed in the soil-cement slope protection. Bechtel states that the crack has no effect on the safety of the dam or its intended function. A copy of the report can be made available to the Corps of Engineers upon request.

Diversion Dam

A. Same comments as Items A and B above.

B. Same comment as Item F above, except this concerns Recommendations 1, 3, and 4 in the Diversion Dam Report.

Sincerely,

Robert J. Labri

RJL/JSP/mm/5:2

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

TED SCHWINDEN, GOVERNOR

32 SOUTH EWING

STATE OF MONTANA

(406) 449-2872 ADMINISTRATOR
(406) 449-3962 WATER RIGHTS BUREAU
(406) 449-2872 WATER SCIENCES BUREAU
(406) 449-2864 ENGINEERING BUREAU
(406) 449-2872 WATER PLANNING BUREAU

HELENA, MONTANA 59620

May 26, 1981

Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Attention: Ralph Morrison

Dear Ralph:

Re: Christian, Spring, Sielback & Associates Dam Safety Inspection Report on Colstrip Evaproation Pond Dam (MT-3211)

We have reviewed the above referenced final draft report. We concur with the findings and recommendations and find that it satisfies the criteria of the Phase I report.

Minor editorial comments have been discussed with your staff, and we understand these will be included in the final report.

Thank you for the opportunity to review and comment on the final draft report on Colstrip Evaporation Pond Dam.

~~Sin~~cerely,

Richard L. Bondy

Richard L. Bondy, P.E.
Chief, Engineering Bureau
(406) 449-2864

RB:AT:lj